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The Effects of Macroeconomic Variables on the BIST 100 Index: ARDL and NARDL Approaches*

Mohammed Algoni[1]

Mehmet İvrendi[2]

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A B S T R A C T

The objective of this research is to analyze the signal, magnitude, and significance of both symmetric and asymmetric effects of interest rate, taxes, exchange rate, oil price, and gold price on the Turkish stock market (BIST100). The autoregressive distributed lag (ARDL) technique was used in both linear and non-linear formats. The F-Bounds test of the linear ARDL test suggests that the variables do not exhibit long-term integration. Nevertheless, the F-bounds test of the nonlinear ARDL (NARDL) test confirms the presence of cointegration among the variables. Therefore, the research heavily relies on the NARDL model. The empirical evidence indicates the long-term influence of the exchange rates rate, gold price, and interest rate on the BIST100 index is asymmetric. Additionally, the asymmetrical effects of interest rates, taxes, exchange rates, oil prices, and gold prices in the short term have an impact on the BIST100.

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[1] PhD Student, Faculty of Economics and Administrative Sciences, Pamukkale University, Türkiye, ORCID: https://orcid.org/0000-0003-1292-8765, gonico1990@gmail.com

[2] Prof. Dr., Faculty of Economics and Administrative Sciences, Pamukkale University, Türkiye, ORCID: https://orcid.org/0000-0002-5944-666X, mivrendi@pau.edu.tr

1. Introduction

Various factors exert an effect on stock price. Several significant macro variables, such as interest rate, taxes, currency exchange rate, oil price, and gold price, impact the stock market's total price. Extensive studies have been conducted on the nexus between these variables and stock price. The findings of researchers frequently demonstrate a robust relationship among interest rate, exchange rate, oil price, gold price, and stock price (Erdem et al., 2005; Hunjra et al., 2014; Rastogi, 2016; Citak & Selçuk 2019; Yacouba & Altıntaş, 2019).

The issue is extensively investigated due to the crucial relationship between interest rates, exchange rates, oil prices, gold prices, and stock markets. The relationship has significant importance for market participants, policymakers, and academicians. Gaining insight into the relationship between these variables can assist market players in making well-informed investment choices; enable policymakers to adopt efficient monetary policies, and aid academicians in advancing financial theories.

To examine the macroeconomic variables that influence stock price in Turkey, we utilize interest rate, taxes, exchange rate, oil price, and gold price as explanatory variables for the fluctuations in stock price models used in the study. We examine the potential nexus between stock price and the previously listed variables as follows:

The correlation between the stock price and the interest rate facilitates investors' ability to transition between stocks and bonds within their investment portfolios. Rising interest rate enhances the yield of bonds, hence exerting a detrimental impact on the stock price. Under such conditions, investors transfer their funds from the stock market to the bank in response to an increase in the interest rate offered by banks to depositors. Uddin & Alam (2010) provide insights, into this behavior. There is not enough information regarding tax revenue that may affect the stock market addressed, even though the majority of the research has focused on the effect of government expenditure represented by the fiscal policy on the stock market. (Aref & Nur, 2021). Exchange rates have become a significant instrument for economic planning in today's free market economy. Financial scholars have shown a growing interest in comprehending the nexus between the stock market and the exchange rate. The growing interest in this matter has been driven by the relaxation of economic laws, leading to a significant increase in foreign capital inflows and outflows for investment and portfolio diversification (Dang et al., 2020).

The correlation between oil price and stock price has been a topic of contention among economists, policymakers, and traders for a considerable period. Jones and Kaul (1996) presented evidence indicating a tenuous link between stocks and oil prices. Moreover, a recent study done by Ankit et al. (2018), Mollick & Amin (2021), and Trabelsia et al. (2021) revealed that oil price have an impact on stock markets. In contrast, Huang et al. (1996) failed to discover any substantiating evidence for a link between stock price and oil price. Furthermore, Chu (2008) contends that a rapid growth

in aggregate demand results in parallel rises in both oil price and stock price. Consequently, researchers may see a robust correlation, even if there may not be an actual causal link.

Throughout the years, Researchers and academics have displayed a strong inclination toward comprehending the nexus between the gold price and stock price. During the 2007 crisis, when the stock market collapsed, the price of gold significantly increased, drawing investors who perceived it as a safe and secure investment. Multiple studies have demonstrated the relationship between the price of gold and the returns on stocks in different markets. Shi et al., (2021) argued that this field of study is complex and challenging to navigate due to the relationship between the two variables is not simply linear, but rather nonlinear affected by many variables.

The primary objective of this research is to assess the influence of fluctuations in the interest rate, taxes, exchange rate, oil price, and gold price on the Turkish stock market (BIST100) by employing linear and nonlinear auto-regressive distributed lag models. To the best of our knowledge, this study is the first examination of the symmetrical and asymmetrical impacts of the four macroeconomic variables discussed above on the BIST100. The empirical section of this study reveals significant nexuses among the four variables that impact BIST100 stocks. This work seeks to address the aforementioned nexuses by integrating two price variables, namely oil and gold price, together with two rates, exchange, and interest rates, into a unified model.

The study comprises five sections. The second section surveys the literature on the relationships between stock price and macroeconomic variables. The third section provides an account of the study methodology and data collection. The fourth section presents the empirical findings. The fifth section provides a conclusion and examines the policy implications of the results.

2. Literature Review

As previously deliberated, the effects of macro variables have a significant impact on stock markets. Numerous scholarly investigations have been conducted to examine the relationship between stock price and macro variables such as interest rate, exchange rate, oil price, and gold price, to reveal the nature of these relationships.

Interest rate theoretically has two potential ways to influence the company's cash flow: adjusting the cash flow capitalization rate and modifying future cash flow projections based on agents' inflation expectations. Alam & Uddin (2010) observed a negative relationship between interest rate and stock prices across a sample of 15 economies, including developing as well as industrialized countries. Similarly, Sentürk, & Dücan (2014) revealed a statistically significant negative effect of exchange and interest rates on Turkish stock market returns. The effect of interest rate on stock market returns is greater than that of exchange rate. Likewise, Massomeh & Omar

(2017) investigated the relationships between long- and short-term interest rate and the stock market in a sample of 12 developing economies and showed short-term effects were seen in nine out of the twelve nations. Guangtong et al. (2021) also presented evidence that the interest rate tends to decrease the returns on stock price, whereas the exchange rate tends to increase in China.

Studies investigating the correlation between fiscal policy and the stock market have produced inconclusive findings. Mbanga (2016) and Laopodis (2009) discovered compelling evidence indicating that fiscal policy has a substantial influence on stock returns. Furthermore, Mbanga (2016) proposed that fiscal policy has a dominating role in shaping the overall equilibrium relationship with the stock market. Nevertheless, Laopodis (2009) observed that the market could not have much confidence in information about budget shortfalls, suggesting a possible market inefficiency. Razin (1990) and Darrat (1988) both discovered substantial delays in the response of stock prices to changes in fiscal policy, indicating a possible lack of efficiency in the stock market.

There are two explanations for the link between the exchange rate and the stock market. The first one was Dornbusch & Fischer (1980), which argued a positive relationship between the exchange rate and stock price. The second one is Frankel (1985), who demonstrated a negative relationship between exchange rate and stock price. Muhammad (2019) employed the ARDL model to assess the impact of the exchange rate on stock returns on the Shenzhen Stock Exchange and found a significant adverse effect. Similarly, Hamad et al., (2020) indicated that the exchange rate has a substantial negative impact on the BIST100 index. Moussa & Delhoumi (2021) demonstrated that interest rate and exchange rate influence stock price in the MENA region. Ürkmez & Bölükbaş (2021) discovered that in the short run, the effects of exchange rate changes are asymmetrical across the BIST-100, which includes indices for the service, industry, and technology sectors in Turkey, but that in the long run, the effects are asymmetrical only across the technology sector index.

In their study, Seri et al. (2015) observed that there was no correlation between the exchange rate and stock price, thereby demonstrating their lack of connection in Pakistan. In contrast to Seri et al. (2015), Çakır (2021) investigated the asymmetrical influence of foreign exchange rate on three prominent stock market indices in Turkey. It was discovered that exchange rate had varying effects on the three primary stock market indexes in both the short and long term.

The relationship between oil price and the stock market is a well-researched subject. There is conflicting evidence about the impact of oil price volatility on stock market results. Andrea & Matteo (2017) analyzed the impact of oil price shocks on the volatility of the US stock market and found that volatility of the stock market was more influenced by unexpected changes in overall and oil-specific demand, resulting in oil price shocks, rather than shocks originating from the supply side. Ikechukwu & Omotayo (2019) also revealed a significant impact of oil prices on African stock markets. Similarly,

Alamgir & Amin (2021) four South Asian countries demonstrated a significant correlation between global oil price and the stock market index, as well as a stock market reaction to both positive and negative oil price shocks in four South Asian countries.

Despite the common expectation that gold serves to mitigate the fluctuations and risks associated with stock market prices during periods of financial instability, empirical findings do not provide strong evidence consistent with the expectation. Some of this evidence is as follows. Taufiq et al. (2015) investigated the nonlinear dynamic relationships between changes in the gold price, movements in stock markets, and stock market volatility for the FTSE 100, the S&P 500, and the NIKKEI 225 and found that gold may not be a favorable investment option in times of financial crises. In the same vein, Muhammad et al. (2016) found no enduring relationship between the KSE 100 index and gold price. Maryam et al. (2018) analyzed the relationship between gold and the HDAX Index of the Frankfurt Stock Exchange and found insufficient evidence to establish a causal relationship between gold and the stock market. Similarly, Trabelsi et al. (2021) analyzed the returns of gold using seven BSE industry indices and revealed that the returns on gold do not exhibit a correlation with the performance of the BSE sectoral index.

This study employs both ARDL (Autoregressive Distributed Lag) and NARDL (Nonlinear Autoregressive Distributed Lag) approaches to analyze the effect of two ratios and two prices on the BIST100 stock index, distinguishing it from previous studies.

3. Data and Methodology

3.1. Data

This study investigates the impact of fluctuations in the interest rate (R), total taxes (TA), exchange rate (EX), crude oil price (O), and gold price (G) on the price of equities listed in the BIST100 index. The data for this study is derived from monthly intervals spanning from May 2009 to November 2021. The data used in this article on stock price, interest rate, total taxes currency exchange rate, and gold price were sourced from the official website of the Turkish Central Bank , The data on crude oil price was obtained from the Energy Information Administration's (EIA) official website . The exchange rate is measured in USD/TL, the price of gold is measured in USD/Kg, the interest rate is measured in weighted average interest rate, and the price of oil is measured in USD/barrel. The BIST100, a capitalization-weighted index, was employed to represent stock price. The composition of this index consists of the 100 companies that are officially listed on the Istanbul stock market. Each variable in this inquiry has been allocated logarithmic forms except interest rate.

3.2. Methodology

This work utilizes the NARDL technique developed by Shin et al. (2014) to incorporate asymmetric connections in the NARDL model. The methodology is based on the following:

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + ut, \quad (1)$$

$$\Delta x_t = v_t \quad (2)$$

y_t and x_t are time series variables, and x_t is decomposed as follows: $x_t = x_0 + x_t^+ + x_t^-$. $And, x_t^+$and x_t^- are partial sum processes of positive and negative changes in x_t, respectively:

$$x^+_t = \sum_{j=1}^{t} \Delta x_t^+ = \sum_{j=1}^{t} max(\Delta x_j, 0), x_t^- = \sum_{j=1}^{t} \Delta x_j^- = \sum_{j=1}^{t} min(\Delta x_j, 0) \quad (3)$$

Schorderet (2001) used this simple approach to modelling asymmetric cointegration based on partial sum decompositions. Schorderet (2003) generalizes this approach and defines the partial sum component stationary linear combination as follows:

$$z_t = \beta_0^+ y_t^+ + \beta_0^- y_t^- + \beta_1^+ x^+_t + \beta_1^- x^-_t \quad (4)$$

y_t and x_t are said to be 'asymmetrically cointegrated' if z_t is stationary. As a result, standard linear (symmetric) cointegration is a particular case of equation (4), which can only be attained if $\beta_0^+ = \beta_0^- \; and \; \beta_1^+ = \beta_1^-$.

Shin et al., (2014) modified the ARDL model created by Shin (1998) and Pesaran et al., (2001) to develop a flexible NARDL model that aids in the development of models for examining interactions that exhibit long- and short-term asymmetry. The following nonlinear ARDL model was utilized to achieve this goal.

$$y_t = \sum_{j=1}^{p} \emptyset_j y_{t-j} + \sum_{j=0}^{q} \left(\theta_j^{+'} x_{t-j}^+ + \theta_j^{-'} x_{t-j}^-\right) + \varepsilon_t \quad (5)$$

where x_t is a $k\mathrm{x}_1$ vector of multiple regressors defined as $x_t = x_0 + x_t^+ + x_t^-$, $\emptyset_j$ is the autoregressive parameter, $\theta_j^+$and θ_j^- are the asymmetric distributed-lag parameters, and ε_t is an iid process with zero mean and constant variance. Shin et al., (2014) concentrated on the case when x_t is decomposed into x_t^+ and x_t^- around a zero threshold, thus allowing to distinguish between positive and negative changes in the rate of x_t. Using Pesaran et al., (2001) as a starting point, Shin et al., (2014) reformulated equation (5) into an error correction model as follows:

$$\Delta y_t = \rho y_{t-1} + \theta^{+\prime} x_{t-1}^+ + \theta^{-\prime} x_{t-1}^- + \sum_{j=1}^{p-1} \gamma_j \Delta y_{t-j} + \sum_{j=0}^{q-1} (\varphi^{+'}_j \Delta x_{t-j}^+ + \varphi^{-'}_j \Delta x_{t-j}^-) + \varepsilon_t$$

$$= \rho \xi_{t-1} + \sum_{j=1}^{p-1} \gamma_j \Delta y_{t-j} + \sum_{j=0}^{q-1} (\varphi^{+'}_j \Delta x_{t-j}^+ + \varphi^{-'}_j \Delta x_{t-j}^-) + \varepsilon_t \quad (6)$$

Where: $\rho = \sum_{j=1}^{p} \phi_j - 1,\ \gamma_j = -\sum_{i=j+1}^{p} \phi_i \ for\ j = 1, \dots, p-1.\ \theta^+ = \sum_{j=0}^{q} \theta^+_j,\ \ \theta^- = \sum_{j=0}^{q} \theta^-_j\ \ ,\ \ \varphi^+_0 = \theta^+_0,\ \ \varphi^+_j = \sum_{i=j-1}^{q} \theta^+_j\ for\ or\ j = 1, \dots, q-1,$ $\varphi^-_0 = \theta_0{}^-, \varphi^-_j = \sum_{i=j-1}^{q} \theta^-_j\ for\ or\ j = 1, \dots, q-1,$ and $\xi_t = y_t + \beta^{+\prime} x_t{}^+ - \beta^{-\prime} x_t{}^-$ is the nonlinear error correction term where $\beta^+ = -\frac{\theta^+}{\rho}$ and $\beta^- = -\frac{\theta^-}{\rho}$ are the associated asymmetric long-run parameters.

Shin et al., (2014) investigated the following reduced form data generating method for $\Delta\ to$ deal with the possibility of non-zero contemporaneous correlation between the regressors and the residuals in equation (6).

$$\Delta x_t = \sum_{j=1}^{q} \Lambda_j \Delta x_{t-j} + \upsilon_t, \tag{7}$$

Here $\upsilon_t \sim\ iid\ (0, \sum v)$, with $\sum v$ being a $k \times k$ positive definite covariance matrix. ε_t is conditionally expressed in terms of υ_t as:

$$\varepsilon_t = \omega' \upsilon_t + e_t = \omega' \left(\Delta x_t - \sum_{j=1}^{q-1} \Lambda_j \Delta x_{t-j}\right) + e_t \tag{8}$$

we substitute equation (8) for equation (6) and rearrange it again, we get the conditional nonlinear ECM shown below:

$$\Delta y_t = \rho \xi_{t-1} + \sum_{j=1}^{p-1} \gamma_j \Delta y_{t-j} + \sum_{j=0}^{q-1} (\pi^{+'}{}_j \Delta x_{t-j}{}^+ + \pi^{-'}{}_j \Delta x_{t-j}{}^-) + e_t \tag{9}$$

$\pi_0{}^+ = \theta^+_0 + \omega,\ \pi_0{}^- = \theta^-_0 + \omega,\ \pi_j{}^+ = \varphi_j{}^+ - \omega' \Lambda_j$, and $\pi_j{}^- =$—$^- - \omega' \Lambda_j$ for $j = 1, \dots\dots, q-1$

Equation (9) is free of residual serial correlation and perfectly corrects for the weak indigeneity of any non-stationary explanatory variables. Because the model is linear in all parameters, including $\theta^+, \theta^-, \pi_i{}^+\ and\ , \pi_i{}^-$ standard OLS may be used to estimate its correctness with confidence. To measure the positive and negative impact of the exchange rate, gold price, and crude oil price on the stock market in Turkey, the study model has formulated the long-run relationship among the variables of interest as follows:

$$ST_t = \propto + \gamma_1 EXC_t + + \gamma_2 R_t + \gamma_3 O_t + \gamma_4 G_t + \gamma_5 TA_t + e_t \tag{10}$$

Where ST represents the logarithm of the BIST100 index, EXC represents the logarithm of the exchange rate, O represents the logarithm of crude oil price, G represents the logarithm of gold price, TA represents the logarithm of total taxes and R represents the interest rate. This study employs the Nonlinear Autoregressive Distributed Lag (NARDL) technique, as proposed by Shin et al. (2014), to examine the asymmetric impacts of the exchange rate, gold price, crude oil price, and interest rate on the stock market. An advantage of this strategy is its ability to distinguish between the differing impacts of positive and negative shocks. The expression of our NARDL model is as follows:

$$\Delta ST_t = \gamma_0 + \sum_{i=1}^{a} \gamma_1 \Delta ST_{t-i} + \sum_{i=1}^{b} \gamma_2 \Delta EXC_{t-i}^{+} + \sum_{i=1}^{d} \gamma_3 \Delta EXC_{t-i}^{-} + \sum_{i=1}^{e} \gamma_4 \Delta R_{t-i}^{+} + \sum_{i=1}^{f} \gamma_5 \Delta R_{t-i}^{-} + \sum_{i=1}^{g} \gamma_6 \Delta G_{t-i}^{+} + \sum_{i=1}^{h} \gamma_7 \Delta G_{t-i}^{-} + \sum_{i=1}^{j} \gamma_8 \Delta lnO_{t-i}^{+} + \sum_{i=1}^{k} \gamma_9 \Delta lnO_{t-i}^{-} + + \sum_{i=1}^{j} \gamma_{10} \Delta lnTA_{t-i}^{+} + \sum_{i=1}^{k} \gamma_{11} \Delta lnTA_{t-i}^{-} + \delta_{12} ST_{t-1} + \delta_{13} EXC_{t-1}^{+} + \delta_{14} EXC_{t-1}^{-} + \delta_{15} R_{t-1}^{+} + \delta_{16} R_{t-1}^{-} + \delta_{17} G_{t-1}^{+} + \delta_{18} G_{t-1}^{-} + \delta_{19} O_{t-1}^{+} + \delta_{20} O_{t-1}^{-} + \delta_{21} TA_{t-1}^{+} + \delta_{22} TA_{t-1}^{-} + \varphi_t \quad (11)$$

4. Empirical Results

4.1. Correlation

A Pearson's correlation analysis was performed with a two-tailed significance criterion of 5% to establish significant correlations between the independent variables and the dependent variable, as well as among the independent variables. Therefore, if any of the independent variables are excluded from the model, the estimate will be erroneous, thus strengthening our claim regarding the need to incorporate all five explanatories' variables in the same model. Furthermore, the results indicate the presence of multicollinearity among the independent variables, suggesting a significant connection and possible collective effect on the dependent variable. Therefore, it is crucial to thoroughly examine the coefficients and consider their individual and combined effects on the dependent variable.

Table 1: Correlation Matrix

	ST	***EX***	***R***	***O***	***G***	**TA**
ST	1					
EX	0.97 (0.0000)	1				
R	0.63 (0.0000)	0.74 (0.0000)	1			
O	-0.42 (0.0000)	-0.52 (0.0000)	-0.31 (0.0001)	1		
G	0.87 (0.0000)	0.89 (0.0000)	0.58 (0.0000)	-0.43 (0.0000)	1	
TA	0.25 (0.0021)	0.35 (0.0021)	0.43 (0.0000)	-0.20 (0.0134)	0.34 (0.0000)	1

Source: Author

4.2. Unit Root Tests

Unit-root tests are employed to ascertain the level of integration of a variable to meet the estimation prerequisites of the NARDL model. To conduct testing, it is necessary to ensure that all variables in the model are integrated at a degree of I (0), I (1), or a combination of the two. Additionally, no variable should be integrated at a

degree of I (2). The Augmented Dickey-Fuller and Phillips-Perron tests evaluate the time series of study variables to see if they exhibit stationarity. Table 1 presents the ADF and PP results. The ADF test in Table 2 indicates that none of the variables are stationary at the level. However, after taking the first difference, all variables become stationary at the 1% significance level, suggesting that all variables are integrated of order 1 (I (1)). The PP test indicates that all variables, except for the interest rate and total taxes, become stationary after the first difference. The interest rate and taxes, however, remain stationary at level I (1, 0). The findings indicate that the NARDL technique conditions align with the study variables, enabling us to examine long-, short-, and asymmetric interactions among the variables of interest. Table 2 displays the results of the unit root tests.

Table 2: Unit root test results

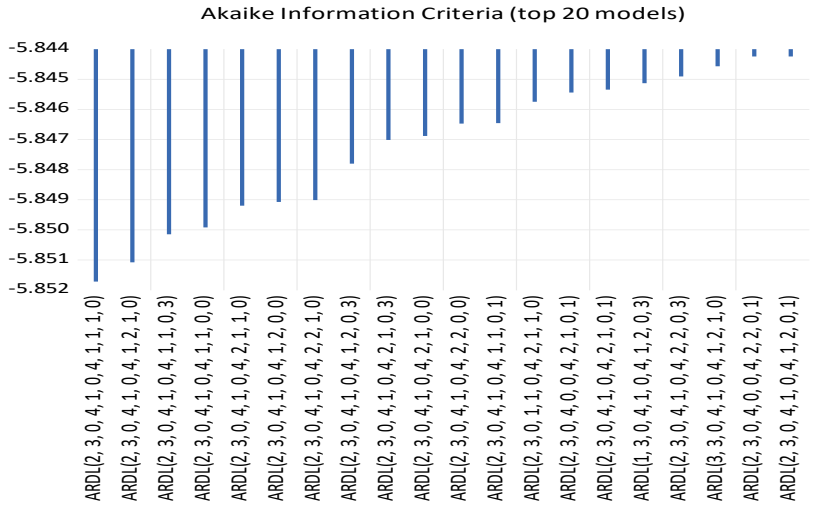
	ADF Test			PP Test		
Variables	**Level**	**First difference**	**Order of integration**	**Level**	**First difference**	**Order of integration**
ST	-0.756	-7.104***	I (1)	-0.948	-7.729***	I (1)
EXC	-2.984	-7.233***	I (1)	-1.939	-6.275***	I (1)
R	-1.891	-12.186***	I (1)	-4.392***	-11.655***	I (0)
O	-1.583	-8.8257***	I (1)	-1.802	-8.794***	I (1)
G	-2.164	-7.7827***	I (1)	-2.005	-7.572***	I (1)
TA	0.489	-8.179***	I (1)	-5.893***	-24.784***	I (0)

Note: ADF indicates the augmented Dickey-Fuller test (1981), and PP indicates the Phillips–Peron (1988). (***) is a 1% level of significance, (**) is a 5% level of significance, and (*) is a 10% level of significance.

4.3. Lags length criteria

The optimal lag length is usually found using model selection criteria such as the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC), or Hannan–Quinn Criterion (HQC) (k). Because every parameter was included in the best-fit model with no interaction effects, the AIC was used to estimate the appropriate lag duration. The AIC criterion also meets the serial correlation conditions. Figure 1 shows twenty models with varied leg lengths, with the model with the lowest value having the leg length (2, 3, 0, 4, 1, 0, 4, 1, 1, 1, 0).

Figure 1. AIC Criteria (top 20 models)



4.4. Bounds test results

The F-Bounds test of co-integration compares the hypothesis that variables are not co-integrated with the hypothesis that they are co-integrated in the long term. If the expected F test outcome is less than the critical values of the lower limits, the null hypothesis is accepted. The null hypothesis is rejected if it is larger. If the test result falls inside the uncertainty zone between the lower and upper boundaries, it is not possible to assess the long-term co-integration of the variables. The study analyzed the links between stock market interest rate, taxes, gold price, exchange rate, and oil price using the linear ARDL model. Given that the F statistic value of 2.76 was lower than the critical value of the upper limits at the 10% level of significance, the F-Bounds test indicated the absence of co-integration between the variables.

According to Shin et al.'s (2014) nonlinear ARDL approach, Table 3 demonstrates that the F-bound test yielded a value of 3.26, above the critical values of 1.98 and 3.04 in the upper and lower bounds respectively, at a significance level of 5%. This demonstrates that variables exhibit cointegration. If one fails to consider asymmetric connections, cointegration tests will not identify any cointegration among the variables of interest. The F-Bounds test of co-integration detects co-integration when the presence of an asymmetric connection is considered. The linear ARDL findings can be obtained upon request, however, we will proceed with the nonlinear ARDL study.

Table 3: Bounds test results of ARDL and NARDL models

ARDL				
F-Bounds Test	Null Hypothesis: No levels of relationship			
Test Statistic	**Value**	**Signif.**	**I (0)**	**I (1)**
F-statistic	**2.76**	**10%**	**2.08**	**3**
k	**5**	**5%**	**2.39**	**3.38**
		1%	**3.06**	**4.15**

NARDL				
F-Bounds Test	Null Hypothesis: No levels of relationship			
Test Statistic	**Value**	**Signif.**	**I (0)**	**I (1)**
F-statistic	**3.26**	**10%**	**1.76**	**2.77**
k	**10**	**5%**	**1.98**	**3.04**
		1%	**2.41**	**3.61**

Source: Author

4.5. Results of the Nonlinear Autoregressive Distributed-lag model

In our analysis, we employed NARDL estimations to examine the influence of exchange rate, interest rate, total taxes, oil price, and gold price on the BIST100 index in Turkey. The NARDL models incorporate the analysis of both short- and long-term impacts, as well as the examination of the adjustment process that takes place when there is a departure from the long-term equilibrium. The impact of interest rate, total taxes, exchange rate, oil price, and gold price on the index may be noted in Table 4.

The BIST100 index in Turkey is subject to varying influences from the exchange rate, as seen by long-term results. Empirical evidence suggests that exchange rate exert a beneficial influence. The highly significant coefficient on EX+ indicates that a 1% depreciation of the lira relative to the dollar is associated with a 0.90% increase in the BIST100 index in the long run. This conforms to economic theory and past academic findings that currency depreciation tends to boost stock market performance in emerging market economies. Various researchers have identified a direct relationship between exchange rate and stock price in Turkey, as well as in other countries (Seri et al., 2015; Dang, 2020; Çakır, 2021). The exchange rate can enhance Turkey's BIST100 index for several reasons. When the value of the Turkish lira depreciates, it reduces the cost of Turkish goods and services, making them more accessible to purchasers. Consequently, firms may experience a surge in exports, income, and stock price.

Furthermore, a devaluation of the currency might enhance the attractiveness of Turkish assets to investors, hence increasing the attraction of Turkish shares. However, no notable negative effects were detected when the local currency, the Turkish Lira, increased versus foreign currencies. Additionally, a more robust domestic currency might potentially mitigate inflation and lower import costs, therefore enhancing the profitability and stock values of enterprises reliant on imports.

Our research revealed that interest rate had significant effects on the BIST100 index. The investigation unveiled a negative impact of interest rate in the long run. These findings indicate that a reduction of one unit in interest rate has the potential to result in a 0.65% rise in the BIST100 index. These findings suggest that when the interest rate is low, there is a potential for an increase in stock price as market players may take advantage of the chance to buy back equities. Several variables might be responsible for the effect of interest rate on Turkey's index. Elevated interest rate can lead to increased borrowing costs, thus dampening investments and consumer expenditure. As a result, this might have an impact on a company's financial gains. Consequently, this led to a decrease in its stock price. These findings are consistent with previous research that has established a link between interest rate and stock price in Turkey (Yacouba & Altntaş, 2019; Çakır, 2020). Nevertheless, it was noted that a rise in interest rate did not have a favorable outcome on the stock market, suggesting that such an increase may not have a substantial impact on stock market performance.

The findings from the long-term analysis indicate that the BIST100 index does not exhibit a statistically significant response to the positive and negative impacts of the oil price, as seen by the non-significant coefficients of O+ and O-.

The findings from the long-term analysis indicate that the BIST100 index does not exhibit a statistically significant response to the positive and negative impacts of the taxes, as seen by the non-significant coefficients of TA+ and TA-.

Table 4 presents the short-term results, indicating an error correction factor (ECM) value of -0.22. The error correction coefficient is expected to have a negative value, which is statistically significant at the 1% significance level. The results indicate that when there is a deviation between BIST100 and the explanatory variables from their long-run equilibrium, it will take about 12 months to correct the deviation for the relationship to return to long-run equilibrium within the 5% range. Given that the adjustment mechanism maintains a regular rate each month, as shown by the ECM coefficient of -0.22. In simple terms, the model's equilibrium response may be considered rather quick since it is typified by an ECM coefficient of -0.22 and a 12-month adjustment period. It indicates a significant, if not particularly quick, adjustment to unexpected shocks.

Table 4: Results of the Nonlinear Autoregressive Distributed-lag model (NARDL)

Panel A: Long-run results:											
Variables	**EX^+**	**EX^-**	**R^+**	**R^-**	**O^+**	**O^-**	**G^+**	**G^-**	**TA^+**	**TA^-**	**constant**
Coefficients	**0.90*** **	**-0.60**	**-0.65*** **	**0.14**	**-0.17**	**-0.13**	**-0.04**	**-0.71*** **	**0.02**	**-0.04**	**2.54*** **
t- stat.	**(3.79)**	**(-1.12)**	**(-4.92)**	**(1.16)**	**(-0.80)**	**(-1.47)**	**(-0.23)**	**(-2.59)**	**(0.35)**	**(-1.13)**	**(70.55)**
Panel B: Short-run results:											
					Lag order						
Variable			**0**			**1**			**2**		**3**
Δ ST						**0.16*** (2.88)**					
Δ EX^+			**1.04*** (10.84)**								
Δ EX-			**0.51*** (3.07)**								
Δ R^+			**0.20*** (-4.07)**			**-0.04 (-0.84)**			**0.16***(3.16)**		
Δ R-											
Δ O^+			**-0.09*** (-2.40)**			**-0.008 (-0.25)**			**0.07**(2.26)**		**0.07**(2.01)**
Δ O-			**0.05 (1.47)**								
Δ G^+											
Δ G-			**-0.25*** (3.38)**			**0.12 (1.61)**			**0.02(0.26)**		**-0.18***(-2.77)**
Δ TA^+			**0.03**(2.34)**								
Δ TA-											
ECMt						**-0.22*** (-6.54)**					

Note: R+, R-, EX+, EX-, G+, G-, O+, O-, TA+, and TA- indicate positive and negative changes in interest rate, exchange rate, gold price, and oil price, total taxes respectively. (***) is 1% level of significance, (**) is 5% level of significance, and (*) is 10% level of significance.

The BST100 is affected by the exchange rate in the short term, with both positive and negative effects that are statistically significant at a 1% level. Both hold significance. A 1% increase in the exchange rate (Turkish lira appreciation) leads to a 1.04% gain in the BIST100 index. A robust Turkish lira against the dollar might potentially have a positive impact on the stock market. This is due to its potential to enhance capital inflows, attract foreign investments, reduce borrowing costs, and stimulate economic growth. These impacts have the potential to enhance stock market investment and price. The BIST100 index increases by 0.51% as the exchange rate decreases by 1%. The stock markets of most nations are adversely affected by the decline of the exchange rate. Nevertheless, it has the potential to provide a temporary surge in the Turkish stock market. The depreciation of the lira might potentially stimulate foreign customers' interest in exports and tourism, benefiting them. Furthermore, a devalued lira might serve as a safeguard against inflation and stimulate the demand for domestically produced items, therefore increasing the value of stocks. The absence of any delay in the influence of the exchange rate on BIST100 suggests that the effects occur at the same time. It aligns with the findings obtained by Mohammed & Şahin in their study conducted in 2020.

The short-term results indicated that a rise of one unit in interest rates (ΔR+) has various impacts on the BIST100 index, depending on the time period. At the beginning, there is a substantial negative effect (with a coefficient of 0.20 and a t-statistic of -4.07), suggesting a 20% reduction in the index. This suggests that implementing contractionary monetary policy, via the increase of interest rates, results in elevated borrowing expenses, less investment, and lower consumer expenditure, thus leading to a decline in stock values. The varying coefficients (-0.04 and 0.16 in subsequent time intervals) show that the impact is not constant over all time intervals. The intricate nature of this phenomenon is a result of the multifarious correlation between interest rates and stock prices. The short-term impact of decreases in interest rates (ΔR-) is not statistically significant. Barut et al. (2017) identified a comparable impact of the interest rate on the BIST100 index in Turkey.

According to the short-term findings, an increase in oil prices has an initial negative effect on the BIST100 index. This effect is quantified by a coefficient of -0.09 (t-statistic: -2.40). These findings indicate that a rise in oil prices corresponds to a decline in BIST100 index values. The negative impacts may be attributed to many reasons, including rising Expenses for Enterprises: Numerous sectors rely on oil for both manufacturing and logistics. Elevated oil prices increase operating expenses, hence diminishing profit margins. Inflationary Pressure: The escalation of oil prices may result in an increase in inflation, which has the potential to diminish the buying ability of consumers and hinder economic expansion. Investors may interpret the rise in oil prices as an indication of a possible economic downturn or higher expenses, resulting in a pessimistic mood in the stock market. Nevertheless, the initial adverse effect of increasing oil prices seems to decrease with time, as seen by the coefficients in successive time periods (-0.008, 0.07, 0.07), which are less negative and even slightly positive. Adverse fluctuations in oil prices (ΔO-): The coefficient for a drop in oil prices is 0.05, with a t-statistic of 1.47, indicating that it is not statistically significant. Consequently, a reduction in oil prices does not have a substantial influence on the BIST100 index in the immediate term. In theory, a decrease in oil prices might result in decreased expenses for companies and less inflationary forces, perhaps leading to a favourable influence on the stock index. Nevertheless, the insignificance of this coefficient implies that other variables or market forces may be exerting a stronger influence than the direct effect of declining oil prices on the stock market. The results align with the study conducted by Citak & Kendirli (2019), which similarly examined the relationship between oil prices and stock returns in Turkey.

The impact of gold prices on the BIST100 index, as indicated by NARDL short-run results, provides a significant insight into the dynamics between gold price movements and stock market behaviour in Turkey. In particular, the negative changes in gold prices (ΔG-) are shown to have a notable influence on the BIST100 index. The coefficient for the initial lag is -0.25 with a t-statistic of 3.38, suggesting a strong negative correlation; a decrease in gold prices leads to a marked decline in the index. This could be interpreted

as gold acting as a safe-haven asset; when gold prices decrease, it may signal investor confidence in the broader economy and a shift away from safe-haven assets, leading to a reduction in stock prices. Alternatively, it could reflect an inverse relationship where investors move away from stocks and into gold as gold prices decrease, thereby reducing the stock index. Subsequent lags show mixed effects with coefficients of 0.12 (t-statistic: 1.61), 0.02 (t-statistic: 0.26), and -0.18 (t-statistic: -2.77). This indicates that the initial strong negative impact of falling gold prices on the BIST100 index is inconsistent over time. The fluctuating nature of these coefficients suggests that while gold prices have an immediate and significant impact on the stock market, this effect becomes less predictable and stable in subsequent periods. This pattern could reflect the complex interplay between gold prices and economic factors, such as inflation expectations, currency fluctuations, and overall market sentiment. The varying degrees of impact across different lags underscore the multifaceted and dynamic relationship between gold prices and the stock market in Turkey, highlighting the need for investors and policymakers to consider a range of factors when assessing the influence of gold price movements on stock market performance. The similar study and outcomes carried out by Saka Ilgın (2019) support the conclusions we have reached.

The short-term NARDL findings indicate that a 1% increase in taxes (ΔT+) is positively and strongly correlated with a 0.03% immediate increase in stock prices. Although it may seem paradoxical, implementing greater taxes has the potential to diminish company earnings and discretionary income. Nevertheless, there are other possible explanations: Rising taxes may serve as an indication of forthcoming government expenditure and a growing economy, which can enhance confidence and improve market prices. Implementing higher tax rates has the potential to enhance fiscal sustainability and enhance the quality of public services and infrastructure in the long term, hence bolstering economic development possibilities. The positive correlation may be attributed to the tax variable's relatively moderate influence compared to other influential factors that affect short-term stock movements. Our findings indicate that there is a positive connection between tax revenue and the BIST100 index, supporting the Keynesian Positive Effect Hypothesis. Ilievski (2015) and Taha (2013) highlight the significance of government involvement in tax collection. Their research reveals an association between tax revenue and the stock market, implying that an upswing in stock market value can potentially result in tax revenues. This observation holds relevance when governments emphasize capital taxes as opposed to income taxes (Aref & Nur, 2021).

The results of asymmetry tests, both for long-term and short-term periods, utilizing Wald's test, are displayed in Table 5. The null hypothesis of the test posits that there is a symmetrical impact. Both in the long and short term, the test statistic surpasses the critical value, indicating that there is an asymmetry in the link between the interest rate and the BIT100 index Both the long-run null hypotheses $R^{+} = R^{-}$and the short-run $\Delta R^{+} = \Delta R^{-}$are rejected with a significance level of 1%. Similarly, the

relationship between the exchange rate and the BIST100 index shows asymmetry in both the long and short run. This means that both the long-run null hypotheses $EX^+ = EX^-$ and the short-term $\Delta EX^+ = \Delta EX^-$ are rejected at a significance level of 1%. This implies that employing linear models to analyze the relationship between the exchange rate and the BIST100 index may result in a model specification mistake. Regarding gold price, our analysis indicates that the null hypothesis $G^+ = G^-$ was not rejected in the long term. This suggests that there is no asymmetry in the relationship between gold price and the BIST100 index over a prolonged period., However, in the short term, we found that the null hypothesis$\Delta G^+ = \Delta G^-$was rejected at a significant level of 1%. This implies that the asymmetric effects of oil price on the BIST100 index are only observed in the short term. The results of Wald's test indicate that the asymmetric relationship between oil price and the BIST100 index is only present in the long term. This is supported by the rejection of the null hypothesis$O^+ = O^-$ at a significance level of 1%However, in the short run, there is no evidence of an asymmetric relationship between oil price and the BIST100 index, as the null hypothesis $\Delta O^+ = \Delta O^-$ is not rejected. Regarding taxes, our analysis indicates that the null hypothesis $TA^+ = TA^-$ rejected in the long term. This suggests that there is asan ymmetry in the relationship between taxes and the BIST100 index over a prolonged period., However, in the short term, we found that the null hypothesis $\Delta TA^+ = \Delta TA^-$ was not rejected at a significant level of 5%. This implies that the asymmetric effects of oil price on the BIST100 index are only observed in the long term.

Table 5: Diagnostic tests and asymmetry tests

Panel A: Diagnostic Tests					
F-test (3053.52*)**	**Adj.R^2 (0.65)**	**RMSET (0.9048)**	**LM (0.5569)**	**ARCH (0.4396)**	**JB (0.114020)**
Panel B: Asymmetry tests:					
Variables			**W_{LR}**		**W_{SR}**
R			-13.7***		7.12***
EX			101.8***		62.5***
G			37.8***		2.55***
O			4.42***		1.75
TA			5.05***		1.04

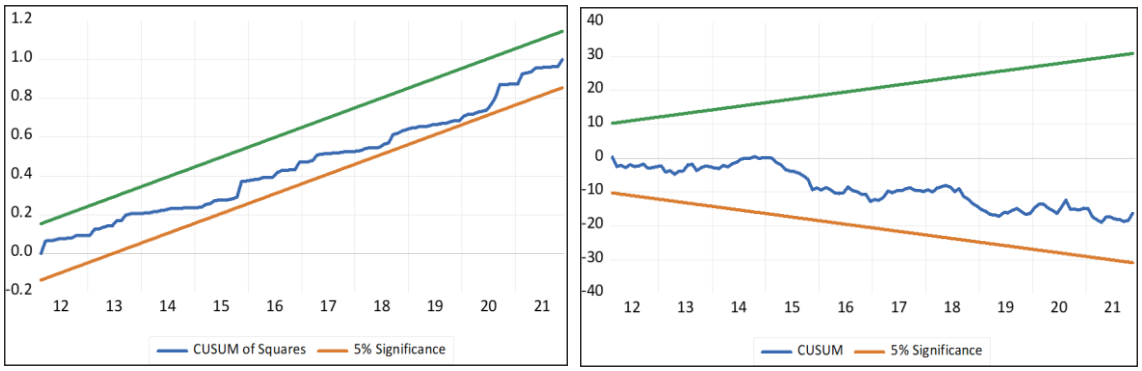
Note: LM indicates the Breusch-Godfrey Serial Correlation test, ARCH indicates the Heteroscedasticity test, RMSET indicates the Ramsey RESET test for model Specification, JB indicates the Jarque-Bera for normal distribution of the residuals, ECM indicates Error correction term, W_LR indicates Wald test for long-run parameters, W_SR indicates Wald test for long-run parameters, (***) is 1% level of significance, (**) is 5% level of significance, and (*) is 10% level of significance.

To assess the stability of the estimated parameters of the model, the variance of the cumulative sum (CUSUM) and cumulative sum squares tests, as proposed by Borensztein et al. (1998), were performed. The stability of the calculated model over

time is demonstrated in Figure 2 at the 5% significance level. The findings indicate that both the parameters and the variance of the estimated model remain consistent over time.

4.6. The stability of the model

Figure 2: The stability of the estimated model



5. Conclusion

The study conducted an extensive investigation of the BIST100 index, examining major macroeconomic factors like currency rates, interest rates, taxes, and oil and gold prices. By using the NARDL and ARDL models, the study revealed important patterns within Turkey's financial system. The clear and asymmetrical effects of these factors, which can be seen in both the short-term and long-term, highlight the complex relationship between macroeconomic policy and market performance.

The intricate impacts of changes in exchange rates on the BIST100 index indicate a multifaceted connection between currency value and market dynamics. The positive association with TL depreciation indicates the possibility of a 'currency depreciation impact,' in which a weaker local currency may increase the attractiveness of the market for foreign investors and improve the competitiveness of export-oriented industries. This pattern is consistent with classical economic theories, which propose that changes in currency values may have significant consequences for a country's trade balance and, therefore, its stock market.

The dynamics of interest rates, on the other hand, show a more complex and intricate picture. The contrasting effects on the BIST100 index, both in the short and long term, highlight the dual role of interest rates as a monetary policy instrument. Interest rate increases, which are usually used to manage inflation or stabilise the currency, seem to have a negative impact on the stock market in the short term. This might be because borrowing becomes more expensive and economic activity slows down. Over time, the

link becomes less certain, indicating a need for a more detailed understanding of how interest rate policies interact with market expectations and economic events.

The significant influence of oil and gold prices on the index corresponds to the global economic storyline, where these commodities often serve as indicators of economic well-being and investor outlook. The results suggest that Turkey's stock market is susceptible to the fluctuations of global commodities markets, emphasizing the necessity for comprehensive risk mitigation and diversification methods to manage this susceptibility.

Notably, the absence of a substantial, uneven effect of overall taxes on the BIST100 index indicates a rather subdued direct influence of the existing tax system on market dynamics. This finding prompts a discussion on the effectiveness and strategic compatibility of fiscal policies with market development goals, specifically capital gains taxes, which may be used to promote a healthier and more robust stock market.

Upon synthesizing these findings, it becomes apparent that policy creation in Turkey must include a comprehensive approach. Monetary policy must be adjusted to include not just conventional objectives such as inflation and currency stability but also its subtle impacts on market mood and investor behavior. Likewise, fiscal policy, specifically tax strategy, should be harmonized with market dynamics to ensure that it promotes market expansion without causing excessive instability.

The intersection of these macroeconomic variables with Turkey's stock market, as revealed by our study, provides a foundational understanding for policymakers. It underscores the importance of coordinated policy actions that balance economic growth, market stability, and investor confidence. Future research should aim to extend these findings by exploring the longitudinal effects of these relationships, particularly in the face of evolving global economic conditions and policy shifts. Such studies are vital for constructing robust economic strategies that not only cater to immediate market realities but also lay the groundwork for sustained economic resilience and growth.

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Peer Review: External independent.

Author Contributions:

Mohammed Algoni - Idea, Purpose, Planning and Design, Literature and Citation, Method, Data Collection, Data Analysis and Discussion, Writing and Format, Final Approval and Responsibility, Overall Contribution - 50%.

Mehmet İvrendi - Idea, Purpose, Planning and Design, Literature and Citation, Method, Data Collection, Data Analysis and Discussion, Writing and Format, Final Approval and Responsibility, Overall Contribution - 50%.

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